

Sources, Characterization, & Communication of Uncertainty in Current Understanding of Climate-Land Interactions at Regional & Local Scales

Poster Presenters - Bryan C. Pijanowski (Purdue) and Brent Lofgren (NOAA)

1. Synopsis

We are a multidisciplinary team of researchers funded by the National Science Foundation to address the question: "what is the nature and magnitude of the interaction between land use and climate change at regional and local scales." Our study site is East Africa (Figure 1), principally the countries of Kenya, Tanzania and Uganda.

This project is among the first to complete the loop (Figure 2) of land use/climate/land use impacts assessment. Its contribution is in analysis of the linkages between components—how does land use change affect climate, and how will climate change affect land use?



Figure 1. Study site for the Climate-Land Interaction Project (CLIP) in East Africa. Shown are countries within our study domain, regional climate model boundaries and locations of case study sites.

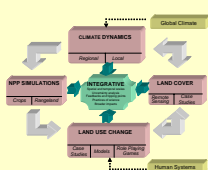


Figure 2. Systems diagram of the major components within the land-climate system. Emphasis is to understand system behavior such as feedbacks, tipping points and how uncertainty can be characterized.

2. Who we are

We are an international multi-disciplinary team, including social, ecological, atmospheric and statistical scientists. We combine our expertise in unique ways to address multiple facets of our research. Our work aids in our understanding of complex systems and how groups can work together across multiple and diverse disciplines.

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Figure 3. Part of the CLIP team (MSU, NOAA and Purdue) at a recent meeting (Oct 2004) at Michigan State University.



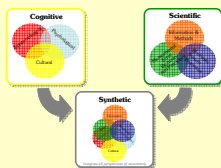
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3. What is Uncertainty?

There are different definitions of uncertainty depending upon the discipline. These include:

Cognitive Scientists: what we perceive is true or possible, or what can be known

Scientists: statistical error and limits (confidence) to understanding based on the scientific method



4. Sources of Uncertainty

Here we provide examples of uncertainty that we are exploring in our NSF study for the various categories outlined below in #3.

A. Scientific

Information. Data used for modeling and analysis can be incomplete (spatially and temporally), not representative of need, have inherent error, or standards for collection may have changed over time. See Figure 4 for illustration.

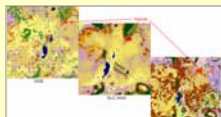


Figure 4. Three different sources of land use/cover derived from independent sources. Note that resolution, complexity of patterns and relative amounts of each category differ.

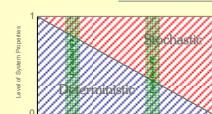


Figure 5. Different systems can have different levels of deterministic and stochastic properties. For example, land use change systems in Brazilian Amazon are more deterministic, influenced by roads, than is land use change in the rural Midwest US where individual decisions of farmland owners, especially decisions to sell portions of land holdings, are difficult to characterize.

Discovery. Lack of rigorous scientific investigations at system interstices; difficult nature, terminology and paradigm challenges within diverse research teams; researcher training differences, lack of integrative theories that encompass biophysical and social sciences. See Figure 6 for illustration.



Figure 6. Research at the intersections of different disciplines, shown here between social scientists studying land use change and ecologists and agriculturalist understanding crop production, require more research than improvement of knowledge within each discipline. Gaps in our understanding include: how to characterize variables in common, exogenous factors influencing each "box" as well as their connections, and theories that integrate paradigms in broad fields, etc.

B. Cognitive

Epistemological. What can be known about future events is limited by many factors, including lack of historical non-analogs; lack of understanding how known factors which act as surprises, effect system behavior, etc. See Figure 7 for illustration.



Donald Rumsfeld, Secretary of Defense. News briefing, Feb. 12, 2002. Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know." (August 2004)

Cultural. How we perceive the real world differs between cultures; understanding of likelihood of future events varies from crisp (yes/no) to probabilistic (maybe, likely, rare). See Figure 8 for illustration.

Culture	Type of Answers	Percent Crisp Answers
Asian (Hong Kong, Indonesia and Malaysia)	Yes, no, don't know	Very large (most)
British	Maybe, probably	Very low

Figure 8. Table at top shows the general results of a study by George Wright (reported in 1988) on answers by two different groups of students to the question, "will you catch a cold in the next three months?". Study was conducted to determine cultural differences to perceptions of uncertainty.

Psychological. What we can learn about the world is limited by barriers to learning; human mind can only synthesize so much information.

Policy. Ability to link scientific research to diversity of policy contexts, relationship of policy to control of factors responsible for system dynamic; veridicality in science and policy; perceptions of disagreements in scientific community and relevance to policy action, ability to match scientific evidence to consensus seeking and truth seeking.

5. Methods to Address Uncertainty

Data Analysis Practices. Examine variance across spatial and temporal scales; identify outliers in data; examine probability distribution functions; aggregate data at different spatial scales and apply multiple data sources to our models and analysis. Promote more in situ data collection and more long term studies. See Figure 9.

Modeling Practices. Use a variety of models to simulate the same process; these models should differ in data requirements and in their assumptions; compare and contrast reduced-form models and process-based models; blend different modeling practices if possible; better communicate model assumptions; do not believe our models de facto but question them and integrate them into the narrative. See Figure 10.

Discovery Practices. Spend time communicating across the disciplines ("talk isn't cheap"); blend practices of science by adjusting your own practice of science; sacrifice advance in the disciplines for advances bridging disciplines; contribute toward system-wide understanding. See Figure 11 for illustration.

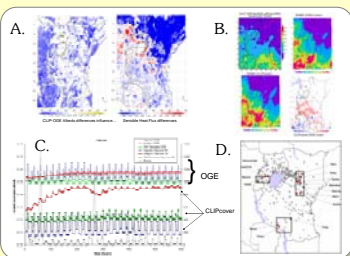


Figure 9. We used two different land use/cover databases (shown in Figure 2) to parameterize our regional climate model (RAMS). A. The difference between observed (model input derived from MODIS) and simulated land use (RAMS output) is shown as difference maps. B. The difference between monthly precipitation simulated using the two land use/cover databases as compared to observed precipitation. C. Comparison of the two land use/cover databases. D. Comparison of the two land use/cover databases and (3) different spatial scales.

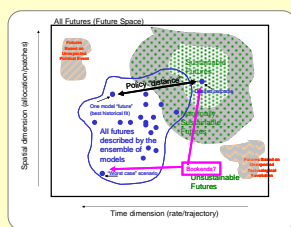


Figure 10. Conceptualization of using model ensembles and plotting outcome of thousands to millions of different model executions in relationship to Delta derived areas of sustainable futures. Approach includes identifying "business as usual", worse case and best case scenarios along with using knowledge elicitation techniques to identify areas outside of model output space that may result in unexpected outcomes that are not included explicitly in model structure.



Figure 11. An illustration of the different tools and techniques being compared from areas of ecology, economics, social science and statistics. These techniques are being used to identify drivers of land use change into the future across all of East Africa. A. Knowledge elicitation techniques of experts. B. Role Playing Simulation. C. A reduced form model that uses GIS and neural networks. D. Narrative stories of case studies.

Institutions whose scientists are contributing expertise:



Climate Land Interaction Project



"What is the nature and magnitude of the interaction between land use and climate change regional and local scales?"

